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SUBJECT: EXPOSURES TO METHYL BROMIDE IN MONTEREY/SANTA CRUZ AND VENTURA COUNTIES BASED ON THE 2002 MONITORING BY THE ALLIANCE OF THE METHYL BROMIDE INDUSTRY

This memorandum gives inhalation exposures as average concentrations of methyl bromide in air for 24-hour, 1-week and 8-week averaging periods, based on monitoring done by the Alliance of the Methyl Bromide Industry (AMBI) in Ventura County in Summer 2002 and Monterey/Santa Cruz Counties in Fall 2002 (AMBI, 2003), and corrections to the data in the AMBI (2003) report provided in a memorandum from Applied Measurement Sciences (Winegar, 2003).

Methods

Following the practice of the Worker Health and Safety (WHS) Branch, this memorandum reports arithmetic mean concentrations and tolerance limits estimated using lognormal methods. Lognormality is assumed for environmental contaminants in most cases. DPR's experience with many large environmental datasets has shown that they are usually well described by the lognormal distribution. In addition, WHS prefers to avoid the inconsistency of using different exposure statistics based on sample characteristics. WHS uses the arithmetic mean concentration because the concentration of interest for exposure assessment is the overall concentration in all of the air that a person could breathe during the averaging period. The arithmetic mean concentration is the best estimate of the average mass of residue per unit of environmental medium; it is equivalent to compositing all of the samples and measuring the concentration of the mixture (Parkhurst, 1998). This is true regardless of the shape of the underlying distribution.

No substitution for nondetected values was required because no samples were reported below the detection limit of 0.003 ppbv. Samples with sampler flow-rate deviations exceeding ±25% had already been removed from the dataset by AMBI. Three more samples with flow deviations were removed from the Monterey data set after further checking by Applied Measurement Sciences (Winegar, 2003). Duplicate daily samples at a site were averaged. The data were not adjusted for background levels (average 0.25 ppbv at the Santa Cruz background site, 0.03 ppbv in Ventura) or recovery (range -2% to 243% in laboratory, trip and field spikes).

24-hr exposure

For each monitoring site separately, the maximum observed and the 95% tolerance limit for 24-hr concentrations are given. The 95% tolerance limit is the concentration that, with given probability, will be exceeded in 5% of future samples (Hahn and Meeker, 1991). It is calculated using lognormal distribution methods:

95% tolerance limit = exp{arithmetic mean of log concentrations + $g_{(..90;95;\, n)}$*(sd of logs)}.

The multiplier g for 90% probability is tabled in Hahn and Meeker (1991).

1-week exposure

For each monitoring site separately, the maximum and the 95% tolerance limit for weekly mean concentrations are given. Each weekly mean is calculated as the arithmetic mean of the 24-hr samples taken at a site during the week (i.e., nonmonitoring days are ignored). The 95% tolerance limit for weekly mean concentrations is calculated using normal distribution methods:

95% tolerance limit = arithmetic mean of week means + $g_{(.90;.95;\, n)}$*(sd of week means).

Normal methods are used in this case because sample means from any distribution tend to be normally distributed.

8-week exposure

For each monitoring site separately, average exposure over the 8-week monitoring period is calculated as the arithmetic mean of the weekly means (calculated as above for 1-week exposure).

Results

Twenty-four-hour, 1-week and 8-week concentrations are given in Table 1. Daily concentrations and intermediate calculations are shown in Tables 2 (Ventura) and 3 (Monterey/Santa Cruz).

Table 1. Methyl bromide concentrations (ppbv) in Ventura and Monterey/Santa Cruz Counties, based on monitoring by the Alliance of the Methyl Bromide Industry in 2002.

		Daily		1-week		8-week
Site [a]	N days	Maximum 24-hr	95% tolerance limit	Maximum weekly[b] mean	95% tolerance limit	Mean of weekly means
		ppbv				
Ventura County, 10 July – 31 Aug, 2002						
ABD	30	3.44	4.48	2.70	3.03	0.76
SHA	31	5.77	5.89	2.28	2.85	0.58
PVW	32	9.51	8.97	6.05	6.94	1.62
UWC	26	13.17	14.20	7.96	9.12	2.22
Monterey/Santa Cruz Counties, 4 Sept – 26 Oct, 2002						
MAQ	32	4.53	6.61	2.62	3.34	1.12
BBC	32	6.28	23.15	5.35	6.44	2.08
WAT	30	16.38	18.51	8.44	10.88	3.79
FRM	31	14.00	12.98	6.64	8.61	2.62
CPW	30	11.12	9.27	4.77	6.11	2.06
SCF [c]	7	0.69	4.70	0.35	1.90	NA

a Monitoring sites described in AMBI (2003).
b Each weekly mean is the arithmetic mean of the 24-hr samples (*n* ranged 2 - 4) in a calendar week.
c SCF site monitored during only 2 nonconsecutive weeks.

Exposure appraisal

The average concentrations presented here are based on limited monitoring data and must be considered as having some degree of uncertainty. The representativeness of the monitoring sites is unknown. Each site was monitored only 2 - 4 days per week for a relatively short (8-week) period. In two cases, a site had usable samples for only two days in a week. Sundays through Tuesdays were not monitored. It is unknown whether days of the week differ systematically in numbers of methyl bromide fumigations.

References

AMBI. 2003. Alliance of the Methyl Bromide Industry Methyl Bromide Air Monitoring: Ventura, Santa Cruz, and Monterey Counties July-October, 2002. Final Report dated April 15. Fair Oaks, CA: Applied Measurement Science.

Hahn, G.J., and Meeker, W.Q. 1991. *Statistical Intervals: A Guide for Practitioners*. New York, John Wiley & Sons, Inc.

Parkhurst, D.F. 1998. Arithmetic versus geometric means for environmental concentration data. *Environmental Science and Technology News.* Feb. 1.

Winegar, E. 2003. Response to DPPR Comments on AMBI 2001 and 2002 Reports. Memorandum to Randy Segawa, DPR, dated June 2 [the memo is incorrectly dated June 2, 2002]. Fair Oaks, CA: Applied Measurement Science.

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Table 2. Daily concentrations and intermediate calculations for Ventura County sites.

Date	Week	ABD	SHA	PVW	UWC	ABD	SHA	PVW	UWC
		ppbv				ln ppbv			
10-Jul-02	1	0.042	0.028	0.21		-3.170	-3.576	-1.580	
11-Jul-02	1	0.092	0.031	0.56		-2.386	-3.474	-0.581	
12-Jul-02	1	0.25	0.013	0.49	0.17	-1.376	-4.343	-0.719	-1.778
13-Jul-02	1	0.18	0.087	0.35	0.36	-1.720	-2.442	-1.056	-1.016
	1 Average	0.14	0.040	0.40	0.27				
17-Jul-02	2		0.11	0.10	0.41		-2.249	-2.293	-0.901
18-Jul-02	2	0.39	0.15	0.63	1.0	-0.955	-1.871	-0.456	0.041
19-Jul-02	2	0.14	0.028	0.30	0.42	-1.959	-3.576	-1.191	-0.858
20-Jul-02	2	0.16		0.15		-1.858		-1.911	
	2 Average	0.23	0.10	0.30	0.62				
24-Jul-02	3	0.88	0.37	0.86	2.1	-0.130	-1.002	-0.149	0.753
25-Jul-02	3	1.9	0.45	0.23	3.2	0.618	-0.805	-1.485	1.173
26-Jul-02	3	0.50	0.63	0.91	0.54	-0.695	-0.470	-0.097	-0.615
27-Jul-02	3	0.18	0.08	0.38	0.64	-1.740	-2.577	-0.968	-0.452
	3 Average	0.85	0.38	0.59	1.63				
31-Jul-02	4		0.041	0.73			-3.194	-0.314	
1-Aug-02	4	0.41	0.060	0.62	0.77	-0.884	-2.813	-0.472	-0.264
2-Aug-02	4	1.0	0.059	0.85	1.5	0.012	-2.830	-0.158	0.417
3-Aug-02	4	0.99	0.43	1.6	7.5	-0.012	-0.835	0.445	2.014
	4 Average	0.80	0.15	0.9	3.3				
7-Aug-02	5	2.0	5.8	5.2	5.2	0.677	1.753	1.644	1.642
8-Aug-02	5	3.4	1.9	6.0	13	1.210	0.648	1.786	2.578
9-Aug-02	5	3.4	1.3	9.5	8.8	1.236	0.276	2.252	2.173
10-Aug-02	5	2.0	0.11	3.6	4.7	0.713	-2.180	1.269	1.553
	5 Average	2.7	2.28	6.1	8.0				
14-Aug-02	6	0.67	0.18	1.3	2.4	-0.400	-1.709	0.287	0.854
15-Aug-02	6	0.36	0.12	1.2	1.5	-1.030	-2.096	0.213	0.373
16-Aug-02	6	0.16	0.089	1.0	1.2	-1.845	-2.419	0.037	0.215
17-Aug-02	6	0.57	0.64	1.2	1.4	-0.571	-0.445	0.202	0.371
	6 Average	0.44	0.26	1.2	1.6				

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Table 2. Continued.

Date	Week	ABD	SHA	PVW	UWC		ABD	SHA	PVW	UWC
		ppbv					ln ppbv			
21-Aug-02	7	0.59	1.4	3.2	1.9		-0.533	0.345	1.161	0.639
22-Aug-02	7	0.62	2.2	3.1	1.7		-0.476	0.796	1.124	0.513
23-Aug-02	7	0.65	0.86	2.4			-0.435	-0.149	0.857	
24-Aug-02	7	0.34	1.2	1.8			-1.067	0.185	0.596	
	7 Average	0.55	1.4	2.6	1.78					
28-Aug-02	8	0.19	0.04	0.28	0.37		-1.677	-3.112	-1.273	-1.000
29-Aug-02	8	0.072	0.004	0.36	0.34		-2.638	-5.521	-1.019	-1.079
30-Aug-02	8	0.22	0.14	1.2	0.44		-1.496	-1.988	0.186	-0.826
31-Aug-02	8	0.98	0.024	1.5	1.2		-0.025	-3.730	0.432	0.178
	8 Average	0.36	0.052	0.8	0.6					
	Mean of week means	**0.760**	**0.584**	**1.619**	**2.217**	Overall mean of days	-0.82	-1.79	-0.10	0.26
	SD of week means	0.824	0.822	1.933	2.506	Overall SD of days	1.12	1.71	1.10	1.13
	Max of week means	**2.701**	**2.278**	**6.053**	**7.961**	n days	30	31	32	26
	n weeks	8	8	8	8					
	95th %ile of week means	2.320	2.142	5.281	6.965					
	90% tol limit on 95th%	**3.028**	**2.848**	**6.942**	**9.119**			ppbv		
						95th %ile of days	2.927	3.058	5.867	8.915
	Max of days	**3.443**	**5.770**	**9.511**	**13.172**	**90% tol limit on 95th**	**4.476**	**5.886**	**8.967**	**14.197**

Table 3. Daily concentrations and intermediate calculations for Monterey/Santa Cruz County sites.

Date	Week	MAQ	BBC	WAT	FRM	CPW	SCF	MAQ	BBC	WAT	FRM	CPW	SCF
		ppbv						ln ppbv					
4-Sep-02	1	0.36	4.1	9.9	2.8			-1.033	1.410	2.293	1.012		
5-Sep-02	1	0.86	2.9	7.5	4.2	1.34		-0.150	1.076	2.012	1.423	0.293	
6-Sep-02	1	1.1	2.0	4.0	5.7	3.5		0.135	0.670	1.387	1.733	1.240	
7-Sep-02	1	1.2	1.0		14.0	2.8		0.156	-0.035		2.639	1.027	
	1 Average	**0.9**	**2.5**	**7.1**	**6.6**	**2.5**							
11-Sep-02	2	0.092	0.37	1.2	0.72	2.3	0.12	-2.386	-0.997	0.145	-0.323	0.837	-2.087
12-Sep-02	2	0.21	0.80	0.65	0.47	0.90	0.24	-1.561	-0.223	-0.435	-0.751	-0.110	-1.448
13-Sep-02	2	0.64	0.85	2.2	1.9	1.2		-0.453	-0.167	0.805	0.667	0.197	
14-Sep-02	2	0.83	1.6	2.1	2.1	1.5	0.69	-0.191	0.490	0.759	0.760	0.389	-0.378
	2 Average	**0.44**	**0.9**	**1.5**	**1.3**	**1.5**	**0.35**						
18-Sep-02	3	2.5	6.3	16.4	6.8	3.0		0.907	1.838	2.796	1.915	1.096	
19-Sep-02	3	4.5	5.5	12	9.8	11		1.511	1.699	2.511	2.279	2.409	
20-Sep-02	3	2.7	3.4	4.1	2.6	2.2		0.981	1.220	1.413	0.972	0.771	
21-Sep-02	3	0.80	6.3	0.94	2.0	2.8		-0.229	1.834	-0.060	0.712	1.027	
	3 Average	**2.62**	**5.3**	**8.44**	**5.3**	**4.8**							
25-Sep-02	4	0.18	0.81	0.83	0.83	1.3		-1.737	-0.217	-0.188	-0.185	0.231	
26-Sep-02	4	0.077	0.50	0.95	0.60	1.0		-2.564	-0.697	-0.056	-0.512	0.044	
27-Sep-02	4	0.43	1.2	3.1	0.45	1.5		-0.856	0.160	1.130	-0.810	0.396	
28-Sep-02	4	0.48	0.004	5.7	4.1	4.1		-0.744	-5.521	1.747	1.407	1.419	
	4 Average	**0.29**	**0.620**	**2.7**	**1.5**	**2.0**							
2-Oct-02	5	1.2	0.54	4.0	1.5	3.2		0.212	-0.612	1.381	0.411	1.166	
3-Oct-02	5	1.3	1.8	3.4	3.6	3.5		0.287	0.560	1.215	1.292	1.240	
4-Oct-02	5	2.1	2.5	3.9	0.79	2.7		0.722	0.910	1.372	-0.237	0.996	
5-Oct-02	5	2.5	2.2		5.3	4.6		0.930	0.779		1.671	1.519	
	5 Average	**1.8**	**1.7**	**3.8**	**2.8**	**3.5**							
9-Oct-02	6	0.76	2.0	0.89	0.25	0.38		-0.278	0.705	-0.112	-1.394	-0.965	
10-Oct-02	6	0.25	4.6	3.0	0.51	0.82		-1.398	1.520	1.091	-0.671	-0.205	
11-Oct-02	6	1.8	3.2	6.5	1.8			0.560	1.161	1.864	0.609		
12-Oct-02	6	1.5	3.1	0.24	1.5	1.5		0.403	1.124	-1.431	0.429	0.415	
	6 Average	**1.1**	**3.2**	**2.64**	**1.0**	**0.9**							

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Table 3. Continued.

Date	Week	MAQ	BBC	WAT	FRM	CPW	SCF		MAQ	BBC	WAT	FRM	CPW	SCF
		ppbv							ln ppbv					
16-Oct-02	7	0.63	2.2	3.5	1.9	0.28	0.018		-0.464	0.810	1.246	0.631	-1.277	-4.017
17-Oct-02	7	0.22	0.24	1.7	1.3	0.53	0.14		-1.532	-1.415	0.543	0.284	-0.633	-1.966
18-Oct-02	7	0.32	0.25	1.0	1.0	0.64	0.094		-1.155	-1.382	-0.003	0.013	-0.448	-2.364
19-Oct-02	7	0.51	0.93	1.3	1.0	0.64	0.43		-0.667	-0.070	0.229	-0.018	-0.448	-0.839
	7 Average	**0.42**	**0.92**	**1.9**	**1.3**	**0.52**	**0.17**							
23-Oct-02	8	0.11	0.30	0.85	0.50	0.49			-2.254	-1.221	-0.158	-0.693	-0.717	
24-Oct-02	8	2.4	1.7	3.0	2.0	2.2			0.869	0.509	1.089	0.672	0.778	
25-Oct-02	8	3.1	3.3	4.4		0.41			1.126	1.208	1.491		-0.904	
26-Oct-02	8	0.39	0.32	0.75	0.60	0.35			-0.955	-1.133	-0.294	-0.507	-1.047	
	8 Average	**1.49**	**1.41**	**2.25**	**1.02**	**0.86**								
	Mean of week means	**1.12**	**2.08**	**3.79**	**2.62**	**2.06**	**0.26**	Overall mean of days	-0.37	0.19	0.86	0.50	0.36	-1.87
	SD of week means	0.80	1.58	2.58	2.18	1.47	0.13	Overall SD of days	1.09	1.42	0.99	0.99	0.90	1.18
	Max of week means	**2.62**	**5.35**	**8.44**	**6.64**	**4.77**	**0.35**	n days	32	32	30	31	30	7
	n weeks	8.00	8.00	8.00	8.00	8.00	2.00							
	95th %ile of week means	2.65	5.08	8.67	6.74	4.85	1.05							
	90% tol limit on 95th%	**3.34**	**6.44**	**10.88**	**8.61**	**6.11**	**1.90**		ppbv					
								95th %ile of days	4.355	13.407	12.694	8.874	6.586	1.529
	Max of days	**4.53**	**6.28**	**16.38**	**14.00**	**11.12**	**0.69**	**90% tol limit on 95th**	**6.61**	**23.15**	**18.51**	**12.98**	**9.27**	**4.70**